

## BALLOONED WIRELESS NETWORK FOR FREE INTERNET ACCESS

MOHIL PANDEY<sup>1</sup> & SUMIT BHATTACHARYA<sup>2</sup>

<sup>1</sup>M.E. Student, MGM College of Engineering and Technology, Maharashtra, India

<sup>2</sup>Professor, Department of Computer, MGM College of Engineering and Technology, Maharashtra, India

### ABSTRACT

Making internet connectivity available for the rural and interior parts of the globe has always been a complex issue. Telecom giants simply cannot bare the excessive costs involved with the string cables for few miles across the badlands and dense forest areas to make more peoples come online. Traditional satellite systems along with the cellular networks have been majorly hampered by the costs of equipments along with the huge sets of data. So, a ballooned wireless mesh network is designed to instantly insure communication simply to consume the data of disaster prone areas, people's safety and relief packages on the occurrence of any calamities when the existing communication system flunks completely. By uniting the multiple balloons hovering above in the sky, an ad hoc mesh network can be formed for instant communication over the affected shelters or disrupted areas. It will enhance the current standard of living for the humans via numerous benefits being offered from the Internet services such as distance learning, vital news, online commerce, needed educational materials, health related information, telemedicine and images of numerous objects. A pilot system was developed to determine its operations and attainment through various emergency applications like VoIP, Disaster Details Systems and Sharing Systems.

**KEYWORDS:** Ad Hoc Networks, Wireless LAN, Wireless Mesh Networks, Wireless Networks, Balloon Internet, Loon Net Emergency Services, Radio Networks, Ballooned Network, Free Access, Internet Access, Pilot System

### INTRODUCTION

Recently, the United Nations' Human Rights Council stated that Internet access was a basic right for every individual. Tim Berners-Lee, maker of the World Wide Web, had also declared that everybody on the planet deserves low-bandwidth connectivity by default. Till date, 2.3Billion people on the globe have an Internet connection, according to 2013 figures from the International Telecommunication Union. Even earlier, the Wall Street Journal [4] reported hazy information on Google's hope to bring the high-speed Internet access to some African countries along with some south-east Asia countries where connectivity is rare.

Now, Google has come out with solid details of ballooned wireless connectivity plan: Project Loon, the balloon-powered effort from the Google[x] lab, targeting to spread low-cost Internet connectivity to everyone on the planet, especially for those living in the dense rural and remote parts of the earth. The multi-billion dollar tech giant generally makes most of its income by just selling online ads to its varying users from its online services. Currently, 88% of its yearly \$60 billion revenue is derived mainly by just selling online ads only. The R&D segments involved with every fat giant on the globe are usually responsible for the company's future growth and huge revenues. Similarly, Google's R&D segment named Google(X) lab where the scientists are working constantly on the very essential, sci-fi-sounding technology solutions to solve some of the really big problems of the world. Google(X) labs: famous for its already two successful big projects named "a driverless car and the Google glass" and was now very keen for working on

its new concepts for serving free wireless internet access via its balloons hovering above in the sky to the people residing below.

The project got its name as 'Project Loon' mainly because of the idea that sounded pretty kooky a bit bonkers kind. This Balloon Internet would provide connectivity to the world's 5 billion unconnected souls, augmenting their lives with important news across the globe, cherished educational stuffs, various lifesaving health relevant knowledge along with images of irritating cats.

## **RELATED WORK**

Already there was an existing technology working on the balloons concept to serve the internet connection across the globe. The technique was named: Emergency broadband access network (EBAN) [10] where a wireless connection was made available with the help of balloons flying in low altitudes (100-500 m). There were many drawbacks associated with this technique for serving connectivity thereby resulting into failures across many disaster prone areas. With its own interest, Google realized the importance of this technique which would open them a new gateway of opportunities if refined properly and served. So, Google hired a new team of specialized engineers, experts and researchers in order to revise this technology for better means. It completely changed the layer being used for keeping the device float in the sky from troposphere to that of stratosphere layer. Along with that some specially devised equipment were being used in order to overcome the drawbacks associated with the previous one and thereby offering some additional benefits to the human society.

### **The Company's Vision**

Google's obsession to solve the world's broadband problem which gave rise to a breath taking experience named: Project Loon. Google's founder Sergey Brin and Larry Page were very keen to see this projects successful implementation across the globe. Being the world's largest advertising network, Google knew that to increase its revenue they got to do something new which opens up a new market for them. As more number of peoples coming online means more searches & selling of online ads via the ones engaged with Google's online services thereby drawing huge revenues inn.

Google had a truly very high concept for establishing the Internet connection through its giant helium filled balloons circling around the globe which are equipped to beam Wi-Fi signals below. The Wi-Fi solution was selected mainly because of its popularity and relatively easier means to deploy. Google's ultimate goal was to have a ring of balloons revolving around the planet, ensuring that accessing web is possible from anywhere on the planet thereby ensuring a faster and effective means to recover from any disasters, when the current communication infrastructure goes down completely.

High-speed Internet is the electricity of today's era, but much of the planet remains in the gas lit era; only around 2.3 billion humans are wired. For sure, it's also in the company's interest to get more people online. While the idea could work, Project Loon's leader Mike Cassidy mentioned, it's still not clear who would pay for operating and maintaining the network of balloons. Google has been fuzzy about its plans; he surmised that the company may be expecting the telecommunication giants will adopt the idea if Google can prove it's commercially feasible. While the entire process seems too costly or logistically daunting for much of the unwired world. And so, Google's hunt to craft a low-price Internet service led it to a key in an unexpected location: the skies. In recent years, Google has commenced on many test (pilot) projects [5] for the successful implementation of this technique. In the US, it's making its own networks of high-speed connectivity across many cities like Missouri, Austin, Kansas, Texas, Provo and Utah. Not just that it's also urging to allocate the idle slots of the T.V spectrum framed as white spaces, for link establishment.

## PROJECT LOON'S DETAILS

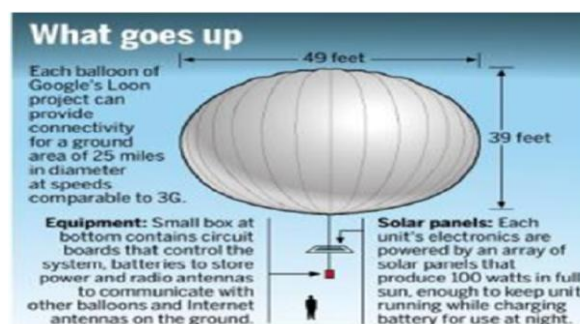
### Project Loon's Definitions

The internet technology seems to be the most transformative technologies of today's era. Only one-third of the entire populations have access to the Internet thereby leaving rest unplugged. Loon net technology is a network of sky-high altitude balloons moving in the space, crafted to serve internet connections to the users below, thereby help in bridging the coverage gaps and get back people online after any disasters when the current communication infrastructure crashes.

Simply, a technology that offers wireless Internet connectivity to the peoples residing in the rural, remote and under-served areas across the globe at today's 3G speed networks or even faster sometimes.

### The Technology Used

While the idea seems to be new, humans have used balloons for transportation, communication and entertainment for centuries. The Loon balloons fly to sky-high altitude almost twice as high as the airplanes and wildlife's fly in the stratosphere. [7] The balloons float around the earth space by means of the stratospheric winds which can be steered by descending or rising to an altitude with the winds moving in the correct direction. Humans establish the links mainly by using a special Internet/Radio antenna attached to their buildings. The signal bounces from one balloon to other, later to the global connections thereby back on the globe.



**Figure 1: The Inner Details of Components Involved in the Balloons [2]**

There won't be just one technology that would turn to be the silver bullet which means that each market will need a unique solutions each time. In some cases, Google ensures to use airwaves/spectrum mend for television broadcasts, but only if government regulators allowed it. Along with that use of satellite networks to boost the connectivity more firmly across the globe are also being considered for the link's establishment developed by O3b network Corp.[11] at cheaper rates.

### Loon's Components

There are many vital parts of the Project Loon which together results in serving the needed wireless internet connectivity to the humans living anywhere on the planet. Some of the very important units involved in the smooth functionality are enlisted below:

#### Balloons

The engineers of Google learned the balloon science technique from the Defense Department, NASA and the Jet Propulsion Lab to craft their own balloons like airships made of plastic sheets similar to that of the grocery bags. Many have been built so far for the successful implantation of the project. The balloons are very durable, tough & light in weight which could bare the pressure and temperature swings above in the stratosphere. It looks similar to that of a robotic jelly-fish which could act as an under-water spy. [11]

Balloons are finally filled with inflammable Helium and air inside which helps in floating high in the sky. These are hand-made ones with a mini Linux based computer and few antennas on board. The high-altitude balloons carry solar-power panels, antennas, radios, mini computers and navigation equipment's that communicates with the specialized antennas below on rooftops.

### **Envelope**

The balloon envelopes are the inflatable parts that are made from polyethylene plastic sheets and stand sixteen meters wide by 11m tall when it is fully inflated. They are specially designed for use in the high super pressure balloons. Also, a parachute is fixed on top of the balloon in order to provide decent landing in case of unusual event of failures. When a balloon is ready to get free from the service, gas is blown out from the envelope to get the balloons low on the earth surface in a controlled manner.

### **Solar Panels**

The electronic part of each unit gets charged up by an array of solar panels that accommodates between the hardware and the balloon's envelope. During the daytime, this panel produces almost 110 Watts of power that ensures the unit running continuously along with charging of batteries which can be used during night wee hours. The Project Loon is designed to get charged itself normally by using renewable sources of energy only and is moving with the help of wind and solar power mainly from the sun.

### **Equipment's**

The electronic equipment hangs below the inflated balloon's envelope in a small box such as the basket being carried away by a hot air balloon. It comprises of mainly circuitry boards and mini computers that completely control the entire system, the radio/Internet antennas to communicate with the other balloons along with the Internet antennas of the base stations, and the batteries which stores solar power so that it can function throughout the night. Radio antennas are mainly build from metamaterials which are synthetic substances that can bend the electromagnetic waves which even natural materials can't. The interference generates a beam which keeps track of the hovering balloons resulting in an unbreakable link connection. Thus, it becomes one of the main candidate for this sci-fi-esque technology as cloaking devices.

### **Balloon's Movement**

The balloon internet floats with the stratospheric winds at very high altitudes from the earth surface. The movement of balloons takes place majorly via the winds and solar energy. The entire process is explained below clearly.

### **Navigation through Winds**

The balloons float around 10 km onwards above the earth crust in the stratospheric layer of the atmosphere. The winds are usually still and slow-flowing at a speed between 5 and 25 mph.[7] As each layers of the wind varies in magnitude and directions. So, it makes use of specially developed complex software algorithms to find where its balloons need to move and thereby move into the layer of winds blowing in the needed direction. The balloons are united to create one large communicating mesh network. No motors are attached here and their travels are largely depending on the wind patterns completely.

### **Stratosphere Layer**

It's found above in the space between 10 km and 60 km altitude and is named after the different layers or strata of

wind within it. Although, there are few engineering constraints involved at this altitude: the air pressure is nearly 1% of that found at sea level, the temperatures are nearly  $-50^{\circ}\text{C}$ , and a very thin layer of atmosphere provides lesser protection from the UV rays and the pressure swings caused by the Sun. It is almost double in altitudes where usually no airplanes and wildlife flies and also got no issues with any weather events.



**Figure 2: The Actual Scenario of the Stratosphere Level above Earth Surface [3]**

With the specially crafted design of the balloon envelope it can bare all such constraints, thereby making it able to reap the benefits from the still stratospheric winds above.

### **Balloon's Inter and Intra Connectivities**

Every balloon can serve the connectivity to a reign about 42 km in diameter at 3G speeds. For inter-balloons and balloon-to-base stations communications, it uses specially crafted antennas packed with specialized radio frequency technology. Project Loon presently uses ISM bands (specifically 2.4 and 5.8 GHz bands) which are available readily for use to anyone. The ISM bands are internationally reserved radio bands for industrial, scientific and medical purposes rather than communications.

Google's Loon algorithm evaluates the navigation of balloons in the sky. Each balloon would serve connectivity for an reign almost double the size of New York City, around 785 square miles, where terrain is not a challenge. It was simply designed to form a ring of floating balloons i.e. a mesh network in order to offer faster and effective means of services. It also makes use of a GPS system for keeping track on the floating balloons location. Along with that there are specially embedded chipsets, circuit boards and a mini LINUX based computers which entirely controls the full fledged system.

### **Loon's Progress**

The Project Loon's pilot test started on June 2013 at New Zealand's Christchurch and Canterbury cities. Till date thirty balloons are launched from New Zealand's South Island [7], which beamed the Internet access to a small group of pilot testers (disaster-strike ones or rural areas). The experiences evolved from these tests will be used to improve the shape and technology used with the Project Loon. Its latest rounds of testing are conducted over California's central valley where developers are using this test to improvise the Loon's power systems & radio configurations. Also, some of the African and south-east Asian countries are next on target for balloon internet usage tests.

### **Working Descriptions**

The balloons float freely in the sky and remains out of our vision thereby lurking powers from the solar panels which are almost table-sized suspended downwards and collect charge in almost five hours to function thoroughly throughout the day where the balloons float on the abounding winds around the globe.[8]

It functions from the ground stations connected to the regular internet infrastructure and transmitting signals to the balloons that are self-charged by the solar panels. Users down have Internet antennae attached on the outside wall of their houses that can simultaneously send and receive radio signals from the balloons passing above. The signals jump forward, from balloon to balloon, apart a support of up to five balloons. The signals move in the unlicensed frequency/spectrum that means it won't go through rigorous regulatory steps needed for Internet service providers thereby using wireless communication satellites or networks. [6]

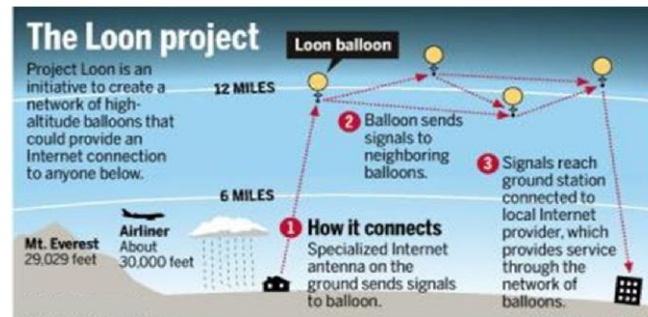


Figure 3: Connecting Stages Involved in Project Loon [1]

The balloons would float in ring forms thereby encircling the planet, wirelessly connecting via a number of base stations, and sends the signals to the other balloons in a daisy chain format. Every station would act as a wireless station for a range of about 28 miles in diameter beneath it thereby making use of a variety of Wi-Fi signals to serve anyone connectivity via a Google-served antenna. Voila!—cheap access internet to those who otherwise wouldn't afford it. Today's smart phone too connect to it are instantly becoming low-cost. Uniting the balloons form a mesh network broadcasting signals until the data reaches a ground station with an optical-fiber link to the Internet.

## HURDLES FACED

There were many blockages which resulted in to delay of projects successful implementation. Along with some huge engineering challenges for its successful implementation there were many political hurdles that were more powerful compared to that of technical ones. As a mean to develop infrastructures used for communications instantly, the wireless mesh network seems to garnered attentions.

Some of the challenges arrived in their path are listed below.

- **Terrestrial Problems:** It comprised of the snowy areas, mountains, rivers, terrains, jungles, etc. where the wired connections are not available.
- **Costs Problems:** The overall costs included in the project were self financed by Google only. So, alternative means were developed to reduce the access charges across the globes.
- **Building & Moving of Balloons:** The balloon sciences were being learned by Google engineers from the experts working on this domain. Also the complexities involved were reduced by controlling the balloon movements through the sky. Only renewable source of energies were being used completely throughout the projects implementation causing its movements also.
- **Establishing Radio Links:** The antennas were being developed by O3n corp. and Kymeta Corp. [11] jointly using metamaterials which are synthetic substances capable of bending the electromagnetic waves which even the natural materials can't do. The resulted interference can produce beams keeping constant track on the balloons above forming an unbroken connection.

## MERITS AND DEMERITS

The various advantages proposed with the usage of Project Loon to its varying users are listed as follows:

- Better speeds are provided in terms of 3G and in some cases it may give 4G for usage with better effective services.
- Easy to use in both user as well as service provider's manner. Only the receiving antenna needs to get installed at the user's end.
- It will leapfrog the liability of layered fiber optical cables which are used almost throughout the globe thereby resulting in a wired free networks and complexities involved with it.
- Bridging the digital divide between the world's nearly 5Billion unplugged users living in the remote interior parts of the globe to that of the approx. 2.3Billion plugged-in ones.
- To get the entire planet come online with a mission to eradicate the problems involved with the world's broadband services.

The very short comings involved with the Project loon are listed below:

- Cost of implementations involved with the project is completely bared solely by Google itself.
- Maintenance parts of the balloons are very tedious & complex thereby requiring further changes if needed.
- Balloons can function for fewer months only say 110+ days thereby again getting replaced if needed in due course of time without affecting the services served to its varying users across the globe.[9]

## CONCLUSIONS

Finally the very breath taking term named "Project Loon" from Google has been successfully implemented in some parts of the planet. Thereby, resulting into a new dawn of era which lets everyone to get online instantly';... and enrich their lives with various important news, health related data along with useful educational materials. So in the upcoming years everyone will have an opportunity to present themselves online in few minutes.

## REFERENCES

1. [http://extras.mnginteractive.com/live/media/site568/2013/0726/20130726\\_093128\\_ssjm0727loon90\\_400.jpg](http://extras.mnginteractive.com/live/media/site568/2013/0726/20130726_093128_ssjm0727loon90_400.jpg)
2. [https://encrypted-tbn1.gstatic.com/images?q=tbn:ANd9GcRA8E3-ILjvG17hyUQfMIJbOnD1sjaQr8uwt5oEEY\\_ZWm8MhTTD](https://encrypted-tbn1.gstatic.com/images?q=tbn:ANd9GcRA8E3-ILjvG17hyUQfMIJbOnD1sjaQr8uwt5oEEY_ZWm8MhTTD)
3. <http://gajitz.com/wp-content/uploads/2013/06/project-loom-internet.jpg>
4. <http://www.citeulike.org/tag/balloon>
5. [http://www.cyberschuulnews.com/rbf\\_Steven\\_Levy\\_On\\_The\\_Untold\\_Story\\_of\\_Googles\\_Quest\\_to\\_Bring\\_the\\_Internet\\_Everywhere\\_by\\_Balloon.html#.UtZS2vQW0c8](http://www.cyberschuulnews.com/rbf_Steven_Levy_On_The_Untold_Story_of_Googles_Quest_to_Bring_the_Internet_Everywhere_by_Balloon.html#.UtZS2vQW0c8)
6. <http://www.foxnews.com/tech/2013/06/15/google-launches-internet-beaming-balloons/>
7. <http://www.google.com/loon/>
8. <http://www.foxnews.com/tech/2013/06/15/google-launches-internet-beaming-balloons>

9. <http://www.webzeest.com/article/530/project-loon-balloon-powered-internet-for-everyone>
10. “Emergency broadband access network using low altitude platform” by Hariyanto, H. TELKOM R & D Centre, Bandung, Indonesia Santoso, H. ; Widiawan, A.K.
11. “Ballooned Wireless Mesh Network for Emergency Information System“ by Shibata, Y. Iwate Prefectural Univ., Iwate Sato, Y. ; Ogasawara, N. ; Chiba, G.